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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte AKINOBU KAKIMOTO,
KENTARO OSHIMO, and MASAHIKO MATSUDO

Appeal 2009-1281
Application 10/511,440[1]
Technology Center 1700

Heard: March 19, 2009[2]
Decided:[3] March 31, 2009

Before TERRY J. OWENS, MARK NAGUMO, and
JEFFREY B. ROBERTSON, *Administrative Patent Judges*.

NAGUMO, *Administrative Patent Judge*.

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[1] Application 10/511,440, *Processing Device Using Shower Head Structure and Processing Method*, filed 25 October 2004 as the national stage under 35 U.S.C. § 371 of an international application filed 22 April 2003. The specification is referred to as the "440 Specification," and is cited as "Spec." The real party in interest is listed as Tokyo Electron Ltd. (Amended Appeal Brief with Appendices, filed 15 April 2008 ("Br."), 1.)

[2] See the court reporter's transcript of record.

[3] The two-month time period for filing an appeal or commencing a civil action, as recited in 37 C.F.R. § 1.304, begins to run from the Decided Date shown on this page of the decision. The time period does not run from the Mail Date (paper delivery) or Notification Date (electronic delivery).

DECISION ON APPEAL

A. Introduction

Akinobu Kakimoto, Kentaro Oshimo, and Masahiko Matsudo ("Kakimoto") timely appeal under 35 U.S.C. § 134(a) from the final rejection[4] of claims 7-19. We have jurisdiction under 35 U.S.C. § 6(a). We REVERSE.

The subject matter on appeal relates to methods of processing semiconductor wafers in the presence of a processing gas, especially for preparing tantalum-based capacitors. (Spec. 2, ll. 11-12.) In particular, Kakimoto is concerned with reforming tantalum oxide (Ta_2O_5) films in the presence of ozone (O_3), in which a carbonic component in the tantalum oxide film is said to be removed as CO_2. (*Id.* at 1-2.) According to Kakimoto, when the gas jet-to-sample distance and the gas jet velocity are within the trapezoidal region shown in Figure 3 (reproduced *infra* at 6), the surface velocity of gas flow on the wafer surface is optimal for wafer processing uniformity, efficiency, and throughput. (*Id.* at¶ bridging 3 and 4; 15, ll. 20-25.)

Representative Claim 12 is reproduced from the Claims Appendix to the Principal Brief on Appeal (bracketed labels refer to an embodiment illustrated in Figure 1, which is reproduced *infra* at 6):

> 12. A processing method for processing an object [W], said method comprising:
>
> loading the object [W] onto a mounting table [32] provided within a processing chamber [4] having a

[4] Office action mailed 20 August 2007 ("Final Rejection"; cited as "FR").

> plurality of gas jetting holes [10] formed on a gas jetting surface [8] facing towards the mounting table [32]; and
>
> injecting a processing gas into the processing chamber [4] through the plurality of gas jetting holes [10] while
>
> > restricting a distance [L1] between the gas jetting surface [8] and the mounting table [32] and a velocity [V1] of the processing gas from the plurality of gas jetting holes [10] to be within an area in a plane coordinates system having the distance as a first axis thereof and the velocity as a second axis that is perpendicular to the first axis, wherein the area has a quadrilateral shape formed by a first line connecting a first point where the velocity is 32 m/sec and the distance is 15 mm and a second point where the velocity is 67 m/sec and the distance is 15 mm, a second line connecting the first point to a third point where the velocity is 40 m/sec and the distance is 77 mm, a third line connecting the second point to a fourth point where the velocity is 113 m/sec and the distance is 77 mm, and a fourth line connecting the third point to the fourth point [Fig. 3].

(Claims App., Br. 22-23; square bracketed labels, reference to Figure 3, and indentation added.)

The Examiner maintains[5] the rejection of claims 7-19 under 35 U.S.C. § 103(a) in view of Park.[6]

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[5] Examiner's Answer mailed 20 May 2008. ("Ans.")

[6] Ki-Yeon Park et al., *Methods of Fabricating Capacitors Including Ta_2O_5 Layers in a Chamber Including Changing a Ta_2O_5 Layer to Heater Separation or Chamber Pressure*, U.S. Patent Application Publication US 2002/0034857 A1 (21 March 2002), based on an application filed on 29 May 2001.

The dispositive issue in this case is whether Kakimoto contends correctly that Park fails to teach or suggest that the distance between the showerhead and the substrate, and the gas velocities, are jointly result-effective variables. (Br. 8-10 and 14-16.)

The Examiner maintains that "one would recognize that when looking at the apparatus labeled in Figure 1, by changing the height relative to the heater Park et al. is also changing the height relative to the showerhead and hence the area as described in the claims . . . " (FR 5, citing Park 4, ¶¶ 41 and 47, and Figure 3). The Examiner argues further that because Park teaches varying the heater-to-sample distance to modify the substrate temperature in order to affect the crystallinity of the film and the leakage current of the Ta_2O_5 layer, it would have been a matter of routine experimentation to optimize the distance into the range recited in the claims. (FR 6.) Moreover, according to the Examiner, adjusting the sample-to-showerhead distance "would obviously effect [sic: affect] the gas jetting velocity relative to the substrate—supporting that the gas jetting velocity is shown to be a result effective variable dependant upon many experimental conditions." (Ans. 7.)

Because we find the Examiner's premise incorrect, we need not consider the arguments of the Examiner or the Appellants regarding the rejections of the remaining claims.

B. Findings of Fact

Findings of fact throughout this Opinion are supported by a preponderance of the evidence of record.

The 440 Specification

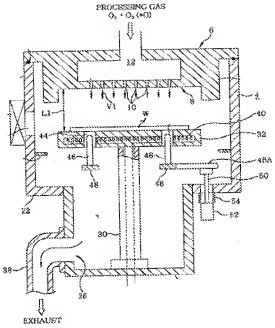
The claimed process is readily comprehended in terms of the apparatus shown in Figure 1, which is reproduced without unnecessary labels on the following page. Processing gas (a mixture of oxygen and ozone) is introduced to processing chamber 4 via a showerhead gas jet assembly 6, which has holes 10 in gas jetting surface 8. (Spec. 8-9.) The gas travels, at velocity V1, a distance L1 from gas jetting surface 8 to a wafer W. Wafer W lies on a platform 32 that is provided with a heater 40. (*Id.* at 11 and 13.) Table 32 is supported by pins 46, which are in turn supported by upthrust ring 48. (*Id.* at 12.) Upthrust ring 48 is connected to up/down rod 50 of actuator 52. (*Id.*) The distance L1 between sample W and showerhead holes 10 is adjusted by changing the elevation of up/down rod 50 via actuator 52. (*Id.*)

According to the 440 Specification, the gas jetting velocity V1 is given by the equation

$$V1 = Q \cdot (273 + T)/(K \cdot A \cdot P \cdot 273),$$

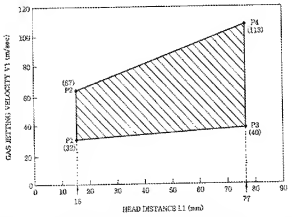
where Q is the gas flow rate, T is the temperature (C) of the showerhead, K is a conversion constant (= 592), A is the total area (m^2) of the gas jetting holes, and P is the pressure (in pascals). (*Id.* at 17-18.) This equation for the gas jet velocity is not expressly dependent on the sample-to-showerhead distance. Moreover, the 440 Specification does not appear to indicate that any of the parameters are dependent on the sample-to-showerhead distance.

{A simplified version of 440 Specification Figure 1 is shown below}[7]



{Figure 1 is said to show a processing chamber with a showerhead gas jet}

The optimal ranges of gas jet-to-sample separation and gas jet velocity are said to be in the shaded trapezoidal region illustrated in 440 Specification Figure 3, which is reproduced *infra*.



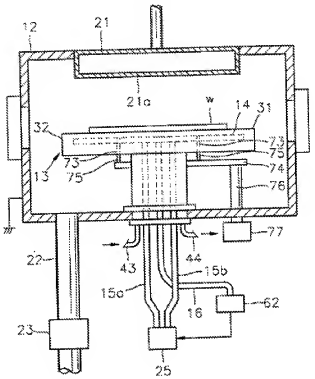
{Figure 3 is said to show the velocity-head distance coordinate plane}

[7] The text in curly braces following the Figures is provided to ensure compliance with section 508 of the U.S. Rehabilitation Act for publication of this Decision on the USPTO website pursuant to the Freedom of Information Act. It is not part of the Decision.

Park

Park describes an apparatus for curing a Ta_2O_5 layer with ozone, which is illustrated in Figure 1, which is reproduced *infra*.

{Park Figure 1 is shown below:}



{Figure 1 is said to show a Ta_2O_5 processing chamber}

Processing gas is introduced to processing chamber 12 via showerhead jet assembly 21, which has holes 21a. (Park 2, ¶ [0028].) The gas strikes sample W, which lies on table 31. Table 31 is positioned over heater 14 (*id.* at ¶ [0030]), which in turn is supported by pins 75 on lift plate 74 (*id.* at 3, ¶ [0031]). The distance between the sample W and the heater 14 can be adjusted via lift plate 74, which is supported by shaft 76 of driving member 77. (*Id.*) Notably, adjusting the height of shaft 76 or the lengths of pins 75 does not change the distance between the sample W and the showerhead holes 21a.

C. Discussion

As the Appellant, Kakimoto bears the procedural burden of showing harmful error in the Examiner's rejections. *See, e.g., In re Kahn*, 441 F.3d 977, 985-86 (Fed. Cir. 2006) ("On appeal to the Board, an applicant can overcome a rejection [under § 103] by showing insufficient evidence of *prima facie* obviousness") (citation and internal quote omitted).

For at least four distinct reasons, the Examiner has failed to establish that a person having ordinary skill in the art would have recognized from Park that varying the distance between the showerhead holes 21a and the sample W *and* varying the velocity of the gas would have resulted in optimization of the result of any process.

First, as Kakimoto argues (Br. 9-10) and as is evident from Park Figure 1, adjusting the position of heater 14 relative to the sample W does not change the distance from the sample W to the showerhead exit holes 21a. Only the distance between the heater 14 and the sample W is changed. Thus, the Examiner's premise is facially incorrect and the rejection must be REVERSED.

Second, even if it were true that variation of the sample-to-heater distance would, in the apparatus shown in Park Figure 1, necessarily result in a variation of showerhead-to-sample distance, the Examiner has not directed our attention to any credible evidence that that distance would necessarily or even desirably have been within the range recited in the appealed claims. This failure to establish a teaching or suggestion of a limitation is also grounds for reversal.

Third, the Examiner has not supported with credible evidence of record the finding that the gas jetting velocity would have varied as a function of distance under the conditions described by Park. Moreover, the Examiner has not provided any reason to doubt the accuracy of the equation presented in the 440 Specification. That equation does not contain any express dependency on the showerhead-to-sample distance, nor do the parameters and variables appear to depend implicitly on that distance. Again, the Examiner has not offered any credible explanation of why the gas jet velocity would have been expected to depend on the showerhead-to-sample distance. In the absence of any teaching to suggest optimization of the gas jet velocity, the obviousness rejection must be REVERSED.

Finally, the Examiner based the conclusion of obviousness on the joint optimization of two independent variables. While it is true that the appealed claims are broad, it is also true that the Examiner has failed to show that the recited parameters of the claimed process would have been the inevitable and obvious result of optimization of even a single variable, where the other variable is fixed within the recited range. Joint optimization of independent variables requires the far stronger (i.e., more highly constrained) teaching or suggestion in the prior art of a reason to optimize *each* variable simultaneously into each range recited in the claim. The Examiner has failed to show that the prior art contains any such teachings. The rejection must be REVERSED for this reason as well.

Having determined that the Examiner has failed to establish the prima facie obviousness of the independent claims, we turn to the rejections of the dependent claims. In these rejections, the Examiner asserts that further limitations would have been met or obvious. The Examiner does not

argue—nor is it apparent—that meeting the further limitations would have resulted in meeting the distance and velocity limitations of the independent claims. Accordingly, the rejections of the dependent claims must also be REVERSED.

D. Order

We REVERSE the rejection of claims 7-19 under 35 U.S.C. § 103(a) in view of Park.

REVERSED

PL Initial:
sld

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& NEUSTADT, P.C.
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